SYLLABUS

FOR M.Sc. (CHEMISTRY)

PG DEPARTMENT OF CHEMISTRY

RAYAGADA AUTONOMOUS COLLEGE,

RAYAGADA

under

Choice Based Credit System (CBCS)

(For the academic session 2022-2024)

POST GRADUATE DEPARTMENT OF CHEMISTRY

Semester-I					
Paper No.	**Subject**	**Marks**	**FM**	**Credits**	**Page No.**
CHE-CC-101	Organic Chemistry-I	80+20	100	04	3
CHE-CC-102	Inorganic Chemistry-I	80+20	100	04	5
CHE-CC-103	Physical Chemistry-I	80+20	100	04	6
CHE-CC-104	Environmental Chemistry	80+20	100	04	7
CHE-CC-105	Organic Practical		100	04	8
Semester-II					
CHE-CC-201	Organic Chemistry -II	80+20	100	04	9
CHE-CC-202	Inorganic Chemistry-II	80+20	100	04	11
CHE-CC-203	Physical Chemistry - II	80+20	100	04	12
CHE-CC-204	Organic Spectroscopy	80+20	100	04	13
CHE-CC-205	Inorganic Practical		100	04	14
Semester –III					
CHE-CC-301	Analytical Chemistry	80+20	100	04	15
CHE-CE-302	Organic Chemistry-III	80+20	100	04	16
CHE-CE-303	Physical Spectroscopy	80+20	100	04	18
CHE-CE-304	Organometallic Chemistry	80+20	100	04	19
CHE-CE-305	Nano Chemistry	80+20	100	04	20
CHE-OE-306	Chemistry & Society	80+20	100	04	21
CHE-CC-307	Physical Practical		100	04	22
Semester –IV					
CHE-CC-401	Organic Synthesis	80+20	100	04	23
CHE-CE-402	Physical Chemistry -III	80+20	100	04	25
CHE-CE-403	Bio-inorganic and Supra Molecular Chemistry	80+20	100	04	26
CHE-CE-404	Polymer Chemistry	80+20	100	04	27
CHE-CE-405	Industrial Chemistry	80+20	100	04	28
CHE-CC-406	Analytical Practical		100	04	29
CHE-CC-407	Project & Seminar		100	04	30

Value added course: 2nd Sem: Material Characterization

3rd Sem: Fundamentals of Green Chemistry

4th Sem: Cultural Heritage of South Odisha

SEMESTER-I

Course No. CHE-CC-101 Course Name: **Organic Chemistry-I**

Semester: I Credits: 4

Course Details

Unit-I

Structure, Reactivity and Bonding in Organic Molecules

Delocalized chemical bonding, Conjugation, Cross conjugation, Resonance, Hyperconjugation, Aromaticity in benzenoid and non-benzenoid compounds, Alternant and non-alternant hydrocarbons, Huckel's rule, energy levels of pi-molecular orbitals of simple systems, Annulenes, Anti-aromaticity, Homo-aromaticity. Acidity and basicity of organic compounds (pKa and pKb value comparison).

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Curtin-Hammett principle. Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Effect of structure on reactivity- resonance and field effects, steric effect, quantitative treatment. Thetreatment. The Hammett equation and linear free energy relationships, substituent and reaction constants. Taft Equation.

Unit-II

Stereochemistry:

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers,R and S notations,Optical purity, specific rotation, enantiomeric excess (ee), diastereomeric ratio.Resolution of racemic modification. Optical activity in the absence of chiral carbon (biphenyls, allenes, spiranes, transcycloalkene and metallocenes), chirality due to helical shape. enantiotropic and diastereotropic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis using chiral reagent, chiral catalysts, chiral auxiliary and chiral substrates (*Felkin-Anh* model and *Cram's* rule). E/Z and syn anti notation for Geometrical isomerism

Unit-III

Name Reactions:

Appel, Bomford-Steven, Baylis–Hillman, Mannich, Mc-Murry couling, Mitsunobu, Nef Reaction, Petasis, Prins, Simmons-Smith,. Reaction related organomettalic basisc idea on oxidative addition and reductive elimination reactions involving triple bond (Sonogashira reaction), C-C (Kumada, Negishi, Heck, Suzuki and Stille reactions) and C-N (Buchwald-Hartwig reaction) cross-coupling reaction.

Unit-IV

Molecular Rearrangements

Pinacol-pinacolone, Wagner-Meerwein, Favorskii, Demjanov, Benzil-Benzilic acid, Smilles, Favorskii and Quasi-Favroski, Arndt-Eistert synthesis, Neber, Beckmann, Bechmann Fragmentation, Hofman, Curtius, Schmidt, Baeyer-villiger, Shapiro reaction, Lossen, Baeyer-Villiger, Book, Carroll, Von-Richter, Benzidine, Bamberger, Wolf Rearrangement

Textbooks:

1. *Organic Chemistry by Clayden, Greeves and Warren, Oxford Univ. Press, 2nd Ed(2012).*
2. *Modern Organic Reactions, H. O. House, W.A. Benjamin. 2nd Ed.(1972)*
3. *Principles of Organic Synthesis, R.O.C. Norman and J. M. Cox, CRC Press 3rd(2014).*
4. *Stereochemistry of Org. Compounds, E. L. Eliel, S. H. Wilen, L.N. Mander, John Wiley & Sons, Inc., New York, (1994).*
5. *A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6thEd.(1999)*
6. *Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part-A and B Springer, 5th Ed(2005)*
7. *Walsh, P. J., Kozlowski, M. C. Fundamentals of Asymmetric Catalysis, University Science Book,2009.*
8. *Ojima, I. Catalysis in Asymmetric Synthesis, Wiley-VCH,2004.*
9. *Carreira, E., Kvaermo, L. Classics in Stereoselective Synthesis, Wiley-VCH,2009.*
10. *Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, McMillan,3rd Ed(2009)*
11. *Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd(1957).*
12. *Introductory Photochemistry, A. Cox and T. Camp.McGraw-Hill.*
13. *Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji,Wilcy-Eastern*
14. *Organic Photochemistry, J. Coxon and B. Halton, Cambridge University Press*
15. *Stereochemistry of Organic Compounds by D. Nashipuri*
16. *Stereochemistry by Kalsi*

Inorganic Chemistry-I

Paper-CHE-CC-102

Unit-I: Covalent Bond

Qualitative discussion on valence bond theory-formation of hydrogen molecule, Qualitative discussion on molecular orbital theory, bonding and antibonding orbitals, energy distribution and stability, MO energy level diagrams of simple diatomic molecules like N_2, O_2, F_2, CO and NO.

Hybridization and wave mechanical description for sp, sp^2 and sp^3 orbitals, qualitative idea about dsp^2, dsp and dsp orbitals, VSEPR theory, shapes of simple molecules and ions, Linnet's double quartet theory and spectra of simple molecules.

Unit-II: Bonding in Co-ordination Compounds

Valence bond theory-strength and short coming, Crystal field theory-effect spin types, CFSE, Evidence for crystal stabilization energy in octahedral, tetrahedral, tetragonal, square pyramidal and square planner fields, Applications of Crystal Field Splitting, Molecular orbital theory (qualitative), MO energy level diagrams, Sigma–pi bonding and their importance in co-ordination compounds

Unit-III: Metal-Ligand Equilibria in Solution

Stepwise and overall formation constants and their interaction, Trends in stepwise constants, Inert and labile complexes, Kinetic application of valence bond and crystal field theories, Kinetics of octahedral substitution, Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Determination of binary formation constants by potentiometric and spectrophotometric methods.

Unit-IV: Nuclear Chemistry

Size and shape of nucleus, binding energy, mass defect, packing fraction, stability, energy of a reaction, nuclear models- the shell and liquid drop model, magic numbers. Modes of radioactive decay and rate of radioactive decay - half-life, average life, radioactive equilibrium, Energetic and types - nuclear fission, nuclear fusion, essential features of nuclear reactors - tracer techniques, neutron activation analysis - carbon and rock dating - application of tracers in chemical analysis, 3 stage nuclear program.

Books recommended

1. *Advanced Inorganic Chemistry*: F. A. Cotton and G. Wilkinson, John Wiley.
2. *Inorganic Chemistry*: J. E. Huheey, E. A. Keiter, R. L. Keiter, Pearson Education.
3. *Inorganic Chemistry*: Missler and Tarr, Prentice Hall
4. *Inorganic Electronic Spectroscopy*: A. B. P. Lever, Elsevier.
5. *Magnetochemistry*: R. L. Carlin, Springer Verlag.
6. *Essential of Nuclear Chemistry*: H. J. Arnikar, ACS.

Physical Chemistry-I

Paper-CHE-CC-103

Unit I:

Quantum chemistry: Black Body radiation, photoelectric and Compton effects, atomic and molecular spectra, particle diffraction, wave-matter duality, Postulates of quantum mechanics, Operator: Linear operator and Hermitian operator, set up quantum mechanics operators (Momentum, Hamiltian and Angular momentum operator); Translational motion: Particle in one and three dimensional boxes, Tunnelling; Vibrational motion of a particle; Rotational motion: particle in a ring, sphere, Rigid rotator; Hydrogen atom and hydrogen like atoms, Shapes of *s*, *p* and *d*-orbitals.

Unit II:

Atomic and Molecular structure (Quantum mechanical approach): Approximation methods: The variation method, Perturbation method (first order, second order), Application of variation methods and perturbation method to Helium atom, The ground and excited states of Helium, Born Oppenheimer approximation, Molecular Orbital theory: H_2^+, H_2, Valence Bond theory: H^+, H_2, Huckel theory of conjugated systems, Bond order and charge density calculation, Application to ethylene, butadiene, cyclopropenyl radical.

Unit III

Symmetry and group theory: Symmetry elements and Symmetry operations, Mathematical requirements for a point group, Group, Subgroup and classes, matrix representation for the E, C_n, σ_v, S_n, Matrix representation of point groups (C_{2v}, C_{3v} C_{4v}), Transformation matrices, Irreducible representation, Construction of character table (C_{2v}, C_{3v}, C_{4v},C_{2h}, D_2, D_{2d}), Mulliken symbolism rules for IR_S, Standard reduction, Direct product.

Unit IV:

Application of group Theory: Symmetry of Normal modes of Molecules: Infrared and Raman activity for C_{2v} and C_{3v}, Linear combination of atomic orbitals (LCAO) theory: In-phase and out phase interaction of atomic orbital wave function; Hybridization scheme for σ and π bonding: D_{4h}, T_d, O_h; projection operator and the ligand group orbitals, Hybrid orbital as linear combination of atomic orbitals, Molecular orbitals theory of coordination compounds: σ and π-bonding in octahedral complexes, Formation of LGOs, Formation of MOs, Construction of MO energy level diagram.

Books recommended

1. K. Veera Reddy, *Symmetry and Spectroscopy of Molecules*, New Age International, Delhi
2. I.N. Levine, *Quantum Chemistry*, 5th edition (2000), Pearson Educ. Inc., New Delhi.
3. A.K. Chandra, *Introductory Quantum Chemistry*, 4th edition, Tata McGraw Hill, New Delhi.
4. L. Pauling and E. B. Wilson, *Introduction to Quantum Mechanics with Applications to Chemistry* (1935), McGraw Hill, New York.
5. R. K.Prasad," *Quantum Chemistry*", Wiley.
6. F.A. Cotton, *Chemical Applications of Group Theory*, Wiley
7. Ramesh Kumari, *Computers and their Applications to Chemistry*, Narosa, New Delhi

Environmental Chemistry

Paper-CHE-CC-104

Environment & Cycles

Environment and its classification, Environmental Impact Assessment and management, Factors influencing environment, Atmosphere: Structure and composition of atmosphere, Environmental degradation, Biogeochemical cycles; Hydrological cycle, Gaseous cycles (Oxygen cycle, Carbon cycle, Nitrogen cycle), Sedimentary cycles (Sulfur cycle, Phosphorous cycle)

Unit-II Natural Resources

Introduction on classification of resources; land resources, formation of soil, soil erosion, Water resources, Sources of fresh water, Uses of water, causes for the depletion of water resources; mineral resources, Forest resources, Deforestation, consequences of deforestation; affords to control deforestation, Renewable and nonrenewable resources, Conventional and nonconventional energy resources

Unit-III

Environmental pollution

Introduction, Pollutants, Types of pollutants, Classification of pollution, effects of pollution, Radiation pollution: sources, effect and control of radiation pollution, Water pollution: sources, effects and its control, Industrial pollution, Air Pollution: Consequences (Ozone layer depletion, Greenhouse effect, Global climate, Smog, Acid rain) Sewage and sewage treatment

Unit-IV

Environmental Chemical Analysis

Working principles and applications: Neutron activation analysis, Anodic Stripping voltametry, Atomic Absorption Spectroscopy, Induced Coupled Plasma Emission Spectroscopy, X-Ray Fluroscence, Fourier Transformation Infra-red, Chemiluminescence, Gas Chromotography, High Performance Liquid Chromatography, Ion-Selectivity Electode, Ion Chromatography, Non-Dispersive IR Spectroscopy

Book recommended

1. Environment and Ecology By Dr. Sunakar Panda
2. Environmental Chemistry By A.K. De
3. Air Pollution by Wark & Werner
4. Environmental Pollution Control in Process Industries By S.P. Mahajan
5. Environmental Chemistry By B.K. Sharma & H.Kaur
6. Introduction to Air Pollution By P.K. Trivedi
7. Environmental Pollution Analysis By S.M. Khopkar
8. A Text Book of Environmental Pollution By D.D. Tyagi, M. Mehre
9. Environmental Pollution Engineering and Control By C.S. Rao

Course Name: **Organic Practical**

Course No. CHE-CC-105

1. Identification of organic compounds having at least two functional group. Submission of derivatives.
2. Synthesis of organic compounds:
    I. Preparation of p- Nitroacetanilide.
    II. Preparation of p- Nitroaniline.
    III. Preparation of Ethylbenzoate.
    IV. Preparation of m-Dinitrobenzene.

3. Estimation of
    I. Acetyl group
    II. Phenolic group
    III. Keto group

4. Preparation of TLC stains and their application in chromatographic techniques for determination of R_f value and separation of organic compounds

Textbooks:

1) Quantitative and Qualitative analysis By A.I. Vogel
2) Experiments and Techniques in Organic Chemistry, D. Pasto, C. Johnson, & M. Miller, Prentice Hall.
3) Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold (Publisher).
4) Hand Book of Organic Analysis, Qualitative & Quantitative, M.T. Clarke, Edward Arnold (Publisher).
5) Vogel's Text Book of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
6) Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath. A Text Book of Practical Organic Chemistry (Qualitative). Arthur I. Vogel

SEMESTER -II

Organic Chemistry-II

Paper-CHE-CC-201

Unit-I:

Aliphatic electrophilic substitutions: SE_1, SE_2 and SE_i– mechanisms, Distinction in between SE_2 and SE_i, Electrophilic substitutions at allylic substrate. Effect of substrate structure, leaving group and solvent on reactivity. Reactions (Hydrogen Exchange, Migration of Double Bonds, Keto-Enol Tautomerism, Halogenation, Aliphatic Diazonium Coupling, Stork-Enamine Reaction).

Aromatic Electrophilic Substitution:

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. orientation in benzene ring with one or more than one substituent, Orientation in other ring systems Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir- Hack reaction, Reimer- Tiemann reaction, Pechmann reaction, Gattermann-Koch reaction.

Unit-II:

Aliphatic Nucleophilic Substitution Reactions: SN2, SN1, Mixed SN1 and SN2, and SET Mechanisms. The Neighboring Group Mechanism, Neighboring Group Participations by Sigma and Pi Bonds. Classical and Non-classical Carbocations, Phenonium Ions, Norbornyl System, Nucleophilic Substitution at Allylic, Aliphatic Trigonal and Vinylic Carbon. Reactivity Effects of Substrate Structure, Attacking Nucleophile, Leaving Group and Reaction Medium, Phase Transfer Catalysis, Ambident Nucleophile, Regioselectivity

Aromatic nucleophilic substitutions:

ArSN (Addition-Elimination) mechanism, Benzyne (Elimination-Addition) mechanism, SRN_1– mechanism, Reactivity effect of substrate structure, leaving group, attacking nucleophile; Von-Richter rearrangement, Sommelet –Hauser rearrangement, Smiles rearrangement. Chichibabin reaction, Displacement in Areno-diazonium Salts by Different Nucleophiles,

Unit –III:

Addition reaction: Electrophilic addition mechanism (syn and anti), Nucleophilic addition mechanism. Addition to conjugated system, Orientation and reactivity

Addition to Carbon-Carbon Multiple Bonds

Mechanistic and stereochemical aspects of addition reactions Hydrogenation, Halogenation, Hydrohalogenation, Hydroboration, Oxymercuration, Sulfenylation, Seleneylation, 1, 3-dipolar species addition, Hydoxylation: Prevost & Woodward hydroxylation, Using KMnO4 and OsO4, Epoxidation, Sharpless asymmetric epoxidation, Michael reaction, Prins reaction, Addition to cyclopropane ring, Addition to conjugated system. SulfoniumYlides addition, Halohydrin addition.

Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, organozinic and organolithium regents to carbonyl and unsaturated carbonyl compounds. Witting reaction. Mechanism of condensation reactions involving enolates – Aldol, Konevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Reformatsky reaction.

Unit IV

Elimination reaction: E_2, E_1 and E_1cb mechanism, Comparison in between E_2, E_1 and E_1cb, Reactivity effect of substrate structure, Attacking reagent, Leaving group and Reaction medium. Orientation, Effect of substrate, base, leaving group and medium, Orientation of double bond, Sayetzeff and Hoffman rules, Pyrolytic elimination, Peterson elimination reaction, Oxidative elimination (oxidaton of alcohol by chromium, Moffatt oxidation). Reactions: Cleavage of quaternary ammonium hydroxides, Chugaev reaction, Shapiro reaction).

Free radical substitutions:

Free radical reactions, Mechanism of free radical substitutions, Neighbouring group assistance in free radical reactions, Free radical substitutions at bridge head. Allylic halogenations, Coupling of alkynes, Arylation of aromatic compounds by diazonium salt Gomberg-Bachmann Reaction, Pschorr cuclisation, Hunsdiecker reaction, Kochi reaction, NBS, Wohl-Ziegler reaction, AIBN,

Books recommended

1. Advanced organic chemistry (McGraw-Hill) J.March.
2. Advanced organic chemistry by F.A.carey andR.M.Saundberg
3. Organic reaction mechanism- SunakarPanda
4. A guide book to mechanism in Organic chemistry (Orient-Longmens)- PeterSykes
5. Organic reaction mechanism (Benjamin) R.Breslow
6. Mechanism and structure in Organic chemistry (Holt Reinh.) B. S.Gould.

Inorganic Chemistry-II

Paper-CHE-CC-202

Unit-I: Metal Π-Complexes

Chemistry of metal carbonyls, Constitution of metal carbonyls: mononuclear, poly nuclear clusters with terminal and bridge carbon monoxide ligand units, Carbonylate anions, Carbonyl hydrides and Carbonyl halides. Metal nitrosyl and other types of metal nitric oxide complexes, Cyanonitrosyl complexes of metals, Brown ring compounds, dinitrogen complexes. Complexes of cyclohexadienyl molecules.

Unit-II: Rings, Cages and Metal Clusters

Inorganic catenation and hetero catenation, Inorganic ring: borazine, phosphorazine and their derivatives, Inorganic cages: borides and carbides, higher boranes, carboranes, metallaboranes and metallacarboranes, compounds with metal-metal multiple bonds

Unit-III: Spectral and Magnetic Properties of Transition Metal Complexes

Spectroscopic ground states, Correlation and Orgel diagrams for transition metal complexes (d -d states), Charge transfer spectra, Elementary idea about magneto chemistry of metal complexes, Diamagnetism, Para magnetism, Temperature independent paramagnetism, Magnetic susceptibility and its measurement, Paramagnetism applied to metal complexes, Ferromagnetism Ferrimagnetism and Anti-ferromagnetism.

Unit-IV: Reaction Mechanism of Transition Metal Complexes

Acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism, Direct and indirect evidences in favour of conjugate mechanism, Anation reactions, Reactions without metal ligand bond cleavage, Substitution reactions in square planar complexes, Trans effect, Mechanism of one electron reactions, Outer-sphere type reactions, Cross reactions and Marcus-Hush theory, Inner sphere type reactions.

Books recommended

1. *Chemistry of the Elements*: N. N. B. Greenwood and A. Earnshow, Pergamon.
2. *Mechanism of Inorganic Reactions*: F. Basalo and R. G. Pearson, Wiley Eastern publication 1967.
3. *Advanced Inorganic Chemistry*: F. A. Cotton and G. Wilkinson, Wiley Estern 1988.
4. *Inorganic Chemistry*: J. E. Huheey, E. A. Keiter, R. L. Keiter, Pearson Education.
5. *Advanced Inorganic Chemistry*: F. A. Cotton and G. Wilkinson, John Wiley

Physical Chemistry-II
Paper-CHE-203

Unit-I: Classical thermodynamics Brief resume of the concept of enthalpy, entropy, free energy and laws of thermodynamics, Partial molar properties, Chemical potential, Effect of temperature and pressure, Determination of partial molar properties by: (i) Direct Method, (ii) Apparent method, (iii) Method of intercept.

Concept of fugacity and its determination by (i) Graphical method, (ii) From equation of state (iii) Approximation method, Nernst heat theorem and its application to solid, Third law of thermodynamics, Experimental determination of entropy by third law.

Unit-II: Statistical thermodynamics

Thermodynamic probability and entropy, Maxwell-Boltzmann statistics, Partition function (translational, vibrational, rotational and electronic) for diatomic molecules, relationship between partition and thermodynamic function (internal energy, enthalpy, entropy and free energy), Calculation of equilibrium constant, Fermi-Dirac statistics, Bose-Einstein statistics, Distribution law and its application to metal.

Unit-III: Non-equilibrium thermodynamics

Thermodynamic criteria for non-equilibrium states, Entropy production and entropy flow, Transformation of the generalized fluxes and forces, Non-equilibrium stationary state, Microscopic reversibility, Onsager's reciprocity relation, Electrokinetic phenomena, Diffusion, Electric conduction.

Unit-IV: Chemical Dynamics

Collision theory of reaction rate, Activated complex theory, Arrhenius equation, Ionic reaction, Kinetic salt effect, Steady state kinetics, Photochemical reaction (Hydrogen-Bromine and Hydrogen- Chlorine reactions), Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, General features of fast reaction, Study of fast reaction by flow method and relaxation method. Dynamics of Unimolecular reactions (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel- Marcus theories)

Books recommended:

1. K.L. Kapoor, *Text book on Physical Chemistry*, Volume 2, Macmillan India Ltd. Delhi
2. P. W. Atkins, *Physical Chemistry*, 7th Edition, (2002) Oxford University Press, New York.
3. Andrew Maczek, *Statistical Thermodynamics,* (1998) Oxford University Press Inc., New York.
4. F.W. Billmayer, Jr., *Text Book of Polymer Science,* 3rd Edition (1984), Wiley-Interscience, New York.
5. K. J. Laidler, *Chemical Kinetics*, Third Edition (1987), Harper & Row, New York.
6. P. W. Atkins, *Physical Chemistry*, Seventh Edition (2002), Oxford University Press, New York.
7. I.N. Levine, *Physical Chemistry*, 5th Edition (2002), Tata McGraw Hill Pub. Co. Ltd., New Delhi.
8. J. Raja Ram and J.C. Kuriacose, Kinetics *and Mechanism of Chemical Transformations* (1993), MacMillan Indian Ltd., New Delhi.

Organic Spectroscopy
Paper-CHE-CC-204

Unit-1: Ultraviolet and Visible spectroscopy

Various electronic transitions (185-800 nm), Beer-Lambert Law, Effect of solvent on electronic transitions, Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes and conjugated dienes, Ultraviolet spectra of aromatic and heterocyclic compounds, Steric effect in biphenyls, Woodword rule (λmax).

Unit –II: Infra-red spectroscopy

Infra-red spectroscopy: Instrumentation, Characteristics vibrational frequencies of simple organic molecules like alkene, alkyne, aromatic compounds, alcohols, phenol, amines, aldehydes, ketones, acids and acid derivatives, Effect of hydrogen bonding and Solvent effect on IR –spectra, Overtones and combination bands, Fermi resonance, FT-IR.

Unit-III

Nuclear Magnetic Resonance Spectroscopy

Basic principle, Chemical shift, Spin-spin interaction, shielding mechanism, Chemical shift values and correlation to protons bonded to carbon and other nuclei, Chemical exchange, Effect of deuteration, Complex spin-spin interaction between two, three, four and five nuclei, Hindered rotation, Shift reagent, Nuclear overhauser effect, AX, AB, AX_2 systems.

Carbon-13 NMR spectroscopy: General consideration, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic, and carbonyl carbon), Coupling constant, Two-dimension NMR spectroscopy: COSY, DEPT, INDEQUATE, HMBC, HMQC techniques.

Unit-IV: Mass Spectroscopy

Introduction, EI, ESI, CI, FD, MALDI and FAB, Factors affecting fragmentation, Ion analysis, Ion abundance fragmentation of organic compounds with common functional groups, Molecular ion peak, Metastable ions, Mc-Lafferty rearrangement, Nitrogen rule, High resolution mass spectrometry, Examples of mass spectra fragmentation for the determination of structure of simple organic molecules.

Books recommended

1. Instrumental Methods of analysis- Willard, Merrit, Dean and Settle.
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Spectroscopic methods in organic chemistry- D.H. Williams and I. Fleming
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Applications of spectroscopic techniques in Organic chemistry- P.S. Kalsi

Inorganic Practical

Paper CHE-CC-205

1. Qualitative analysis of mixtures containing not less than six radicals (organic radicals should be excluded). Anyone of the following rare metal ions may be included.

   a) V b) Mo c) W d) Ti

2. A) Volumetric analysis involving EDTA as reagent.

   i) Determination of Ca^{2+} and Mg^{2+} in Dolomite.

   ii) Determination of Nickel in Stainless steel.

   OR

   B) Complete analysis of:

   i) Brass ii) Cement iii) chromo iron ore.

   OR

   C) Preparation of Hexamine Cobalt (III) chloride.

Book recommended

Quantitative and Qualitative analysis By A.I. Vogel

SEMESTER-III
Analytical Chemistry
Paper-CHE-CC-301

Unit-I Thermal methods of analysis

Thermo analytical methods: TGA, DTGA and DTA, Instrument, Instrumental and application to physical studies (reaction kinetics and information for the constitution of phase diagram), Analytical applications.

Unit-II Electrical methods of analysis

Voltametry and polarography: Dropping mercury electrode, Ilkovic equation, Current-potential curves, Reversible reactions, The residual current, Current maxima, Analytical applications, Amperometric titration using rotating platinum electrode, Cyclic voltammetry.

Unit-III Analysis of Food and Soil

Analysis of food: Moisture, ash, crude protein, fats and carbohydrates. Food adulteration-common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products, Thin layer chromatography for identification of chlorinated pesticides in food. Separation of pesticides by HPLC.

Analysis of soil: Moisture, pH, total nitrogen phosphorous, silica, lime, magnesia, manganese, sulphur and alkali salts.

Unit-IV

Analysis of Fuel and Drugs

Fuel analysis: Solid, liquid and gas. Liquid fuels-flash point, Aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.

Drug analysis: Narcotics and dangerous drugs. Classification of drugs. Screening by gas and thin layer chromatography.

Analysis of data: Types of errors, determinate error, indeterminate error, minimisation of error, Accuracy and precession. Mean (Average Deviation), Standard deviation, Median, Methods of repeating analytical data, statistical evaluation of data, statistical analysis. Problems.

Organic chemistry-III

Paper-CHE-CE-302

Unit-I: Pericyclic Reactions

Molecular orbital symmetry, Frontier orbital of ethene, 1,3- Butadiene,1,3,5-Hexatriene, Allyl system, Classification of pericyclic reactions. Woodward – Hoffmann correelation diagrams. FMO and PMO approach. Electrocyclic reactions – conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions – antarafacial and suprafacial additions, 2+2 and 4+2 cycloaddition, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions. Sigmatropic rearrangements: suprafacial and antarafacial shifts of H, sigmatroic shifts involving carbon moieties, 3,3 – and 5,5 – sigmatropic rearrangements. Claisen Rearrangement Some variants of Claisen rearrangement (Johnson, Ireland, Eschenmoser, Abnormal, Asymmetric aromatic), Cope rearrangement, Cope, and Aza-cope, Oxy-cope rearrangements. Fluxional tautomerism, Ene reaction. [*i,j*] shifts of C-H and C-C bonds 1,5-hydrogen shift, 1,7-hydrogenshift. Sommelet-Hauser rearrangement

UNIT II: Organic Photochemistry:

Electronic excitation, fate of excited molecule (singlet, triplet state), Jablonski diagram & Fluorescence-Phosphorescence. Photo isomerization, Photo-dissociation reactions: Norrish Type-I & II cleavage, Photo-Fries rearrangement, Paterno-Buchi reaction, Barton reaction, Hofmann-Loffler-Freytag reaction, Dinone-Phenone reaarangement, Di-Pi methane rearrangement. Photochemistry of alkenes, dienes & aromatic compounds. Intramolecular reactions of the olefinic bond – geometrical isomerism, cyclisation reactions, rearrangement of 1,4 – and 1,5 – dienes, Photochemistry of Carbonyl Compounds. Intramolecular reactions of carbonyl compounds Cyclohexadienones, Photodimerisation of carbonyl compounds. Photochemistry of Aromatic Compounds Ring Isomerisations, additions, & substitutions, Cyclization reaction. Cis-Trans Isomerization, Dissociation, Photochemistry of arenes, Photochemistry of Arenes

Unit-III Oxidation:

Different oxidative processes, Oxidation of hydrocarbon, alkanes, aromatic ring, alcohol, α, β- diol, allylic and benzylic alcohols, aldehydes ketones, carboxylic acids, amines, oxidation of alcohols by various reagents, and methods, oxidation of carbon-carbon double bonds to diols and epoxides, Oxidation with RuO_4, Idobenzene diacetate, $Tl(NO_3)_3$, PCC, PDC, SeO_2., DMSO Chromium (VI),Manganese (VII) oxidants, Oxidation with peracids, oxidation with hydrogen peroxide, with singlet oxygen. Dichlorodicyano benzoquinone (DDQ), Oxone, Dioxiranes, Tetramethyl piperidine nitroxide, Singlet oxygen, Ozone, N-sulfonyl oxaziridine, Dakin oxidation, Dess-Martin, Moffat,Jones, Wacker.

Unit IV Reduction:

Different reductive processes, Reduction of alkenes, alkynes, aromatic rings, cycloalkanes, carbonyl compounds, aldehydes, ketones, acids and their derivatives, Catalytic hydrogenation using Pd, Pt, Rh, Ni on solid support, selectivity of reduction, Reduction by hydride transfer reagents: Aluminium alkoxide, Lithium aluminium hydride (LAH) and Sodium borohydride (NaBH4), di isobutylaluminium hydride, Sodium cyanoborodydride, Lithium trialkylborohydride, Free radical reagent, Silane based reagents, reduction with hydrazine and diimide, reduction with trialkyltinhydride, Dissolving metal reduction, the Birch reduction, the Wolff-Kischner reduction, the Cannizarro reduction, the Resenmund reduction

Books for Organic Chemistry

1. Organic reaction and mechanism- SunakarPanda
2. A guide book to mechanism in Organic chemistry (Orient-Longmens)- PeterSykes
3. Organic reaction mechanism (Benjamin) R.Breslow
4. Mechanism and structure in Organic chemistry (Holt Reinh.)B. S.Gould.
5. Organic chemistry (McGraw-Hill)Hendrikson, Cram andHammond.
6. Basic principles of Organic chemistry (Benjamin) J. D.Roberts and M.C.
7. Stereochemistry of Carbon compounds. (McGraw-Hill)E.L.Eliel
8. Organic Stereochemistry (McGraw-Hill) byHallas.
9. Organic reaction mechanism (McGraw-Hill) R. K.Bansal.
10. Organic chemistry- R. T. Morrison and R. N. Boyd, (PrenticeHall.)

Physical Spectroscopy

Paper-CHE-CE-303

Unit-I: Electronic Spectroscopy

Atomic spectroscopy- Energies of atomic orbital, Spectra of hydrogen atom alkali metal atom. Molecular spectroscopy-Energy levels, Vibrational progression and geometry of excited state, Frank-Condon principle. Electronic spectra of poly atomic molecule

UNIT-II: Vibrational Spectroscopy

Infra –red spectroscopy: Vibrational energy of diatomic molecules, zero point energy, force constant and bond strength, Morse potential energy diagram, vibrational-rotational spectroscopy, P,Q,R branches, break – down of Oppenheimer approximation, vibration of polyatomic molecules, Selection rules, Hot bands.

Raman Spectroscopy: Classical and quantum theories of Raman effect, Pure rotational, vibrational and rotational Raman spectra Selection rule, Mutual exclusion principle, Coherent anti Stoke's- Raman spectroscopy.

Unit-III

Microwave spectroscopy: Classification of molecules, Rigid rotator model, Intensities of spectral lines, Effect of isotopic substitution on transition frequencies, Non-rigid rotator, Stark effect, applications.

Photo electron spectroscopy: Basic principles, Photoelectric effect, Ionisation process, Koopmans's thermo photoelectron spectra of simple molecules, ESCA, Chemical information from ESCA, Auger electron spectroscopy.

Unit-IV

Electron spin resonance spectroscopy: Basic principles, Zero- field splitting and Kramer's degeneracy, Factors affecting the g value, Isotopic and anisotropic hyperfine coupling constant, Measurement techniques, Application.

Mossbauer spectroscopy: Basic principles, Spectral parameters and spectral display, Application of the techniques to study the bonding and structure of Fe^{2+} and Fe^{3+} compounds (structure of $Fe_3(CO)_{12}$, Iron-sulfur proteins).

Books recommended

2. Fundamentals of molecular spectroscopy by C. N. Banwell, Tata McGraw Hill.
3. Physical chemistry by P. W. Atkins. ELBS. 1986
4. Introduction to molecular spectroscopy by G. M. Barrow.
5. Molecular spectroscopy by I. N. Levins, Wiley interscience.
6. Nuclear magnetic Resonance by J. D. Roberts, Mcgrew Hill.
7. Electron Spin Resonance, Elemenatry theory and practical applications by J. E.Wetz and J. R. Boulton, McGrew Hill

Organometallic Chemistry

Paper-CHE-CE-304

Unit-I

Main Group Organometallics; Synthesis and reactions of organolithium compounds; Synthesis and reactions of organomagnesium compounds; Organometallics of zinc and mercury: preparation, structure, bonding and reactions of aluminum organyls; Thallium(I) organyls (synthesis of TlCp); Organyls of sodium, synthesis of NaCp; Silicon and tin organyls of coordination number 4.

Unit-II

Transition Metal–Carbon σ-Bond: Brief review of metal alkyl compounds; transition metal carbene and carbyne complexes; transition metal vinylidene and transition metal allenylidene complexes. (b) Transition Metal-Carbon π-Bond: Cyclopropenyl cation ($C_3R_3^+$) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph), cyclopentadienyls as ligand

Unit-III

Transition Metal-Carbon π-Bond: (a) Alkene complexes: Synthesis; Bonding; Reactivity. (b) Alkyne complexes: Synthesis; Bonding; Reactivity. (c) Cyclopropenyl cation ($C_3R_3^+$) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph). (d) Syntheses of Cyclopentadienyl and Arene Metal Analogues; Synthesis and reactions of cyclopentadienyl metal carbonyls, cyclopentadienyl metal hydrides, cyclopentadienyl metal halides, arene metal carbonyls, η6 - arene-chromium tricarbonyl in organic synthesis.

Unit-IV

Applications to Organic Synthesis and Catalysis; Stiochiometric reactions for Organometallic catalysts: Dissociation & Substitution, Oxidative addition & carbonylation, Oxygen transfer from Peroxo and Oxo Species, Reductive & Hydride elimination, Insertion, Displacement and Isomerization reaction, Hydrogenation, Hydrosilation and Hydrocynation of unsaturated compounds, Hydroformylation, Wacker (Smidt) Process, Olefin Metathesis, Fischer-Tropsch synthesis, Zeigler-Natta polymerization, Water gas reaction

Textbooks:

1. Inorganic Chemistry-Principles of Structure and Reactivity: J. E. Huheey, E. A. Keiter, R. L. Keiter, Harper-Collins, NY, 4th Ed. (1993).
2. Organometallic Chemistry: A Unified Approach R. C. Mehrotra & A. Singh, New Age International, 2nd Ed. (2000).
3. The Organometallic Chemistry of the Transition Metals: R. H. Crabtree, John Wiley 3rd Ed. (2001).
4. Basic Organometallic Chemistry: Concepts, Synthesis and Applications B. D. Gupta & A. J. Elias, Springer Science, 2nd Ed. (2013).
5. Organometallics 1, M. Bochmann, Oxford University Press, New York (1994).
6. Organometallics 2, M. Bochmann, Oxford University Press, New York (1994).

Nano Chemistry

Paper-CHE-CE-305

Unit-I

Introduction to nano scale Science and Technology: Nanotechnology, Classification of nanostructures, Summary of the electronic properties of atoms and solids: The isolated atom – Bonding between atoms - Giant molecular solids - The free electron model and energy bands - Crystalline solids -Periodicity of crystal lattices - Electronic conduction; Effects of the nanometre length scale - Changes to the system total energy - Changes to the system structure - How nanoscale dimensions affect properties Fabrication methods: Top-down processes, Bottom-up processes, Methods for templating the growth of nanomaterials, Ordering of nanosystems

Unit-II

Synthesis and Stabilization of Nano particles: Chemical Reduction; Reactions in Micelles, Emulsions; Photochemical and Radiation Cryochemical Synthesis: Physical Methods; Particles of Various Shapes and Films.

Unit-III

Experimental Techniques: Electron Microscopy: Transmission electron microscopy (TEM), Scanning electron microscopy (SEM): Diffraction Techniques: X-ray diffraction, Neutron diffraction and some miscellaneous Techniques: X-ray fluorescence spectroscopy, UV- visible spectroscopy

Unit-IV

Applications of Nanoparticle: Cataltysis on Nano particles, Semiconductors, Sensor, Electronic Devices, Photochemistry and nanophotonics, Application of Carbon Nano tubes, Nanochemistry in Biology and Medicine

Text books:

1. Nanomaterials and Nanochemistry, Br‘echignac C., Houdy., and Lahmani M. (Eds.) Springer Berlin Heidelberg New York. 2007.
2. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
3. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
4. Bio-Inspired Nanomaterials and Nanotechnology, Edited by Yong Zhou, Nova Publishers.
5. Nano:The Essentials: Understanding Nanoscience and Nanotecnology, T. Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

Chemistry and society

Paper-CHE-OE-306

Unit-I Chemicals in food:

Carbohydrates: Classification, sugar and non-sugar, Glucose, fructose, starch and cellulose. Importance of carbohydrates.

Amino acids: Classification, essential and nonessential amino acids, Zwitter ion structure, polypeptides, proteins (classification and function).

Lipids: Classification, oils and fats, metabolism of lipids.

Vitamins: Classification, Nomenclature and disease caused by the deficiency of vitamins.

Unit-II Chemicals in Medicines:

Development of new drugs, different types of drugs, analgesics, antipyretics, antiseptics and antibiotics, broad spectrum antibiotics. Metals in medicines: Metal deficiency and disease, toxic effect of metals.

Unit-III Chemicals in Agriculture:

Fixation of Nitrogen, fertilisers, classification of fertilisers: nitrogenous, phosphorous and potassium fertiliser. Pesticides classification, insecticides, fungicides and rodenticides. Detrimental effects of pesticides (DDT, BHC, Parathion).

Unit-I V Chemicals in daily life:

General idea about soap, synthetic detergents and shampoo, preparation of soap and synthetic detergents. Advantage and disadvantage of synthetic detergent, cosmetics and perfumes. Plastic and its determintral effects on environment.

Textbooks:

1. Chemistry in Context: Applying Chemistry to Society, 9th Ed, American Chemical Society, ISBN 9781260222029.

2. Aurand, L. W. and Wood, A. E. (1973). Food Chemistry. The AVI Publishing Co., Connecticut.

3. Belitz, H. D., Grosch, W. and Schieberler, P. (2004). Food Chemistry. Springer, Berlin.

4. DeMan, J. M. (1999). Principles of Food Chemistry. A Chapman and Hall Food Science Book, Aspen Publ., Inc., Gaithersburg, Maryland.

5. Fennama, O. R. (ed). (1996). Food Chemistry. Marcel Dekker, Inc., New York

6. Meyer, L. H. (1976). Food Chemistry. Reinhold Publ. Corporation, New York.

7. Potter, N. M. (1995). Food Science. The AVI Publishing Co., Connecticut.

8. Chemistry and Medicines: An Introductory Text, James R Hanson; RSC.

9. Textbook of Agro-Chemistry by H. P. Hegde, Discovery Publishing Pvt. Ltd (2009).

Physical Chemistry Practical

Paper-CHE-CC-307

6 Hrs duration F.M.-100

1. Determination of surface excess of amyl alcohol
2. Determine the critical Micelle Concentration (CMC) of surfactant from the measurement of surface tension.
3. To determine the Molecular weight of a polymer from viscosity measurements.
4. To determine the Isoelectric point of gelatine and to find out the Intrinsic Viscosity at isoelectric point.
5. Determination of critical solution temperature (CST) of phenol-water system
6. A study of phase diagram of three-component liquid (ternary) system at room temperature: (Benzene- acetic acid-water system)
7. To determine the strength of HCL and acetic acid (AcOH) from the mixture of acids by strong alkali (NaOH) conductometrically.
8. Potentiometric titration of a weak acid (acetic acid) with caustic soda solution and determination of the dissociation constant of the acid using quinhydrone electrode at room temperature
9. To determine the energy of activation from the Kinetic measurement of hydrolysis of ester
10. Determination of rate constant of inversion of sucrose by polarimeter and also verification of the effect of catalyst on the rate constant.
11. First order rate kinetics for acid catalyzed hydrolysis of methyl acetate.
12. Second order rate kinetics for base catalyzed hydrolysis of ethyl acetate.

Book recommended

1. Physical Chemistry Practical by Saroj Kr Maity and Naba Kr Ghosh
2. Experimental Physical Chemistry by R.C. Das and B. Behera
3. Text book of Quantitative Inorganic Analysis by A.I. Vogel,ELBS(1978)
4. Experimental Physical chemistry by J B Yadav, Goel Pub. House, (1981)
5. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987).
6. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
7. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)

SEMESTER IV
Organic synthesis
Paper-CHE-401

Unit-I Disconnection approach

Disconnection approach An introduction to Synthons and synthetic equivalents, disconnection approach, functional group interconversions. One group C-X and two group disconnections in 1,2,1,3- ,1,4-& 1,5- bifunctional compounds, Chemoselectivity, reversal of polarity, cyclisation reaction, amine synthesis. **Protecting Groups**: Principle of protection of alcohol, amine, carbonyl and carboxyl groups. **One Group C-C Disconnection** Alcohols and carbonyl compounds, regioselectivity, Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis. **Two Group C-C Disconnections** Diels-Alder reaction, 1,3-difunctionalised compounds, α, β - unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation. One group disconnection, (alcohol, carbonyl compound, olefins and acids), Two group disconnections (beta-hydroxy compounds, alpha,beta-unsubstituted carbonyl compounds,1,3-dicarbonyl compounds, 1,5 dicarbonyl compounds), Synthesis of some organic molecules by disconnection approach.

Unit-II Retrosynthesis

Synthetic design: Introduction, Retrosynthetic approach, Terminology in Retro synthetic analysis, Retro-synthesis of Alkene, acetylenes and aliphatic nitro Alcohols and carbonyl compounds, amines, the importance of the order of events in organic synthesis, chemoselectivity, regioselectivity. Diels Alder reaction, Michael addition and Robinson annulation. Retro-synthesis of aromatic Heterocycles and 3, 4, 5 and 6 membered carbocyclic and heterocyclic rings. **Synthesis of some Complex Molecules** Application of the above in the synthesis of following compounds. Camphor, Longifoline, Cortisone, Reserpine, prostaglandin, Juvabione, Aphidicolin and Fredericamycin A.

Unit-III Synthesis of Heterocyclic Compounds

Structure, aromaticity and synthesis of 5-6 membered ring containing one heteroatom (Pyrrole, thiophene, Furan, Pyridine, Quinoline, isoquinoline, indole). Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine. Fischer indole synthesis and Madelung synthesis, Doebner Quinoline synthesis, structure of quinoline and isoquinoline. Derivatives of furan: Furfural and furoic acid Electrophilic substitution, addition reaction, oxidation, reduction and other important reaction of Pyrrole, thiophene, Furan, Pyridine, Quinoline, isoquinoline, indole. Bischler-napiealski,

Unit –IV

Reagents in Organic Synthesis

Gilman's reagent, Lithium dimethyl cuprate, Lithium diisopropyl amide, DCC, 1,3-Dithiane, Trimethyl sillyl iodide, Tri-n-butyl tin hydride, Osmium tetroxide, Phase transfer catalysis (Crown ether, Merrifield resin, Wilkinson's catalyst), lead tetra acetate, Dichloro dicyano benzoquinone (DDQ). Grubb’s Catalyst. PPA, Fenton’s Reagent,

Book recommended

1. S.Warren: Designing of organicsynthesis
2. J. Fuhrhop & G. Penzlin.: Organic synthesis (2nded.)
3. Carruthres: some modern methods of organic synthesis.
4. H.O.House: modern syntheticreaction.
5. Fieser & Fieser : Reagent in organicsynthesis
6. R.O.C. Norman: principle of organicsynthesis
7. CAREY & Sundharg: Advanced organic Chemistry

Physical Chemistry-III
Paper-CHE-CE-402

Unit-I Electrochemistry-I

Electrochemistry of solution: Ion-solvent interactions, Born Model, Ion-ion interactions: Debye-Huckel (ion-cloud), Bjerrum Model, Thermodynamics of electrified interface equations; Ion transport in solution: Debye Huckel-Onsager equation, Derivation of Butler-Volmer equation, Tafel plot.

Activity and activity coefficient, Ionic strength, Debye-Huckel limiting law and its verification, Degree of dissociation and its determination, Determination of activity coefficient by freezing point, Vapour pressure and solubility measurement, Ion association, Association constant, Determination of dissociation constant of electrolyte.

Unit-II Electrochemistry-II

Semiconductor interfaces, Theory of double layer at semiconductor, Electrolytic solution interfaces, Structure of double layer interfaces, Effect of light at semiconductor solution interface, Fuel cell, Corrosion: Homogeneous theory forms of corrosion, corrosion monitoring and prevention.

Electromotive force, Measurement of EMF, Relationship between EMF and thermodynamics parameters (free energy change, enthalpy change and entropy change), Thermodynamics of reversible cells, Electrode potential in terms of osmotic pressure and solution pressure. Nernst equation relating electrode potential and concentration.

Unit-III Surface Chemistry

Adsorption, Surface tension, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Gibb's adsorption isotherm, Estimation of surface area (BET equation), Surface films on liquids (electrokinetic phenomenon), Catalytic activity at surfaces.

Micelles: Surface active agents, Classification, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting CMC of surfactants, Counter ion Binding to micelles. Thermodynamics of micellization, Phase separation and mass action models, Solubulisation, Microemulsion, Reverse micelles.

Unit-IV Solid state

Crystal systems and lattices, Miller planes, Crystal packing, Crystal defects; Bragg's Law, Ionic crystals, Band theory, Metals and semiconductors, Types of solid state reactions.

Books recommended

1. J.O'M. Bockris and A.K.N. Reddy, *Modern Electrochemistry*, Vol. 1 & 2A and 2 B, (1998) Plenum Press, New York.
2. Y. Moroi, *Micelles : Theoretical and Applied Aspects*, (1992) Plenum Press, New York.
3. F.W. Billmayer, Jr., *Text Book of Polymer Science*, 3rd Edition (1984), Wiley-Interscience, New York.

Bio-inorganic and Supramolecular Chemistry

Paper-CHE-CE-403

Unit-I: Bioinorganic Chemistry of Alkali and Alkaline Earth Metals

Essential and trace elements in biological systems, structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump; ionophores: valinomycin and crown ether complexes of Na+ and K+; ATP and ADP; photosynthesis: chlorophyll a, PS I and PS II; role of calcium in muscle contraction, blood clotting mechanism and biological calcification.

Unit- II: Metalloproteins

Heme proteins and oxygen uptake, Structure and functions of haemoglobin, myoglobin, hemocyanin and hemerythrin, Iron-sulphur proteins: rubredoxin and ferredoxins, Nitrogenase, Bio-inorganic aspects of nitrogen fixation.

Unit- III: Metalloenzymes

Zinc enzymes – carboxypeptidase and carbonic anhydrase, Iron Enzymes – catalase peroxidise and cytochrome p-450, Copper enzymes – superoxide dismutase, Mg enzymes – vitamin B_{12}.

Unit IV: Supra molecular Chemistry

Molecular recognition: Spherical recognition, Recognition of anionic Substrate, Tetrahedral recognition, Co receptor molecules and multiple recognition, Binding and recognition of neutral molecules.

Supra molecular reactivity and catalysis. Molecular assembly in supra molecular chemistry.

Supra molecular devices: Suitable binding, photochemical and electrochemical sensor wires.

Books Recommended:

1. *Principle of Biochemistry (Lehninger)*: D. L. Nelson and M. M. Cox, W. H. Freeman and company, New York.
2. *Fundamentals of Biochemistry*: D. Voet, J. G. Voet and C. W. Pratt; John wiley and sons.
3. *Bioinorganic Chemistry*: Bertini, Gray, Lippard, Valentine, Viva Books Private Limited.
4. *Supramolecular Chemistry*: J. M. Lehn; VCH

Polymer Chemistry
Paper-CHE-CE-404

Unit-I

Basics of Polymer: Importance of polymers, Basic concepts: Monomer, repeat units, degree of polymerization, Linear, branched and network polymers, Classification of polymers, Polymerization: Condensation, addition, radical and coordination polymerization, Polymerization conditions and polymer reactions, Polymerization in homogenous and heterogeneous systems.

Unit-II

Polymer Characterization: Polydispersion-average molecular concept, Number, weight and viscocity average molecular weights, Polydispersity and molecular weight distribution, Practical significance of molecular weight, Measurement of molecular weights, End group, viscosity, Light scattering, osmotic and ultracentrifugation methods, Analysis and testing of polymers, chemical analysis of polymers, Spectroscopic methods, X-ray diffraction study, Microscopy, Thermal analysis and physical testing-tensile strength, Fatigue impact, Tear resistance, Hardness and abrasion resistance.

Unit-III

Structure and Properties: Morphology and order in crystalline polymers-centrifugation of polymer chains, Crystal structure of polymers, Morphology of crystalline polymers, strain induced morphology, crystallization and melting, Polymer structure and physical properties crystalline melting point, melting points of homogenous series, effect of chain flexibility and other steric factors, entropy and heat of fusion, Glass transition temperature, Tg, Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking, Property requirements and polymer utilization

Unit-IV

Properties of Commercial Polymers: Polyethylene, poly vinyl chloride, polyamides, phenolic resins, epoxy resins and silicone polymers, Functional polymers- Fire retarding polymers and electrically conducting polymers, Biomedical polymers –contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

Textbooks:

1. Textbook of Polymer Science: F. W. Billmeyer Jr, Wiley
2. Polymer Science: V. R. Gowariker, N. V. Biswanathan and J. Sreedhar, Wiley, Eastern.
3. Physics and Chemistry of Polymers: J. M. G. Cowie, Blackie Academic and Professional.

Industrial Chemistry

Paper: CHE-CE-405

Unit-I

Petroleum and coal based chemicals: Composition of petroleum, cracking processes, commercial production of Ethylene, Acetylene, Polymerisation mechanism, addition, condensation, step growth, chain growth, method of polymerisation, distillation of coal.

Unit-II

a) Oil based industries: Oils and fats, solvent extraction of oils, hydrogenation of oils, use of oil in the manufacturing of soap, paints and varnishes.
b) Surface active agents: Classification and manufacturing of detergents used for cleaning purpose.
c) Fermentation industries: A general discussion of Fermentation conditions, manufacturing of Penicillin.

Unit-III

Pesticides and Pharmacological industries: Manufacture of DDT, BHC, Parathion manufacture. Pharmaceutical industries.

Unit-IV

Stoichiometry and unit operation: Distillation, Absorption and Stripping, Extraction and leaching, crystallisation, Psychometric, Drying, Evaporation, less conventional operation.

Textbooks:

1. Analytical Chemistry by G. D. Christain
2. Introduction to chromatography: Bobbit
3. Instrumental Methods of analysis (CBS)- H.H. Willard, L.L. Mirrit, J.A. Dean
4. Instrumental Methods of Analysis: Chatwal and Anand
5. Instrumental Methods of Inorganic Analysis (ELBS): A.I. Vogel
6. Chemical Instrumentation: A Systematic approch- H.A. Strobel
7. The principals of ion-selective electrodes and membrane transport: W.E. Morf
8. Physical Chemistry – P.W. Atkins
9. Principal of Instrumental Analysis- D. Skoog and D. West

Project and Seminar

Paper-CHE-CC-406

Each student has to work for at least 200 hours in a reputed research laboratory or industry on a specific project under the guidance of a Professor/Reader/lecturer or a Scientist. The research work will be submitted in the form of a dissertation within 15 days of last theory examination. The student has to present his work before an External examiner and an Internal examiner for evaluation.

Analytical Practical
Paper-CHE-CC-407

6 Hrs duration F.M.-100

1. To find out the dissociation constant of the given tribasic acid, i.e. phosphoric acid by treating it against NaOH using a pH Meter
2. Determination of hydrolytic constant (Kh) of ammonium chloride solution pH-metrically.
3. To estimate the iron content in the given ferrous ammonium sulphate solution by Colorimetry
4. To determine the composition and stability constant of Fe(III) –salicylic acid complex colorimetrically by Job's method of continuous variation.
5. To determine the Λ^{o} and K_a of weak electrolyte at a definite temperature by Debye Huckel Onsagar equation.
6. To determine the stoichoimetric ratio in the complexometric titration of $HgCl_2$ against potassium iodide conductometrically.
7. To determine the total cation concentration in natural water.
8. To estimate the amount of Na^{+} ion in a given sample using ionisation resin column.
9. Potentiometric estimation of Mohr salt solution with standard potassium dichromate solution and also determination of formal potential (reduction) of ferric-ferrous system.
10. Determination of activity solubility product of silver chloride by emf measurement

Book recommended

1. Physical Chemistry Practical by Saroj Kr Maity and Naba Kr Ghosh
2. Experimental Physical Chemistry by R.C. Das and B. Behera
3. Text book of Quantitative Inorganic Analysis by A.I. Vogel, ELBS (1978)
4. Experimental Physical chemistry by J B Yadav, Goel Pub. House (1981)
5. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987).
6. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).
7. Practical Physical Chemistry by A.M James and P. E. Pritchard, Longman's Group Ltd (1968)